(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
12 December 2002 (12.12.2002)

PCT

(10) International Publication Number
WO 02/098734 A1

(51) International Patent Classification[7]: B64C 1/12, B32B 7/00

(21) International Application Number: PCT/SE02/00843

(22) International Filing Date: 30 April 2002 (30.04.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0102083-3 7 June 2001 (07.06.2001) SE

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(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (utility model), DE, DK (utility model), DK, DM, DZ, EC, EE (utility model), EE, ES, FI (utility model), FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK (utility model), SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR,

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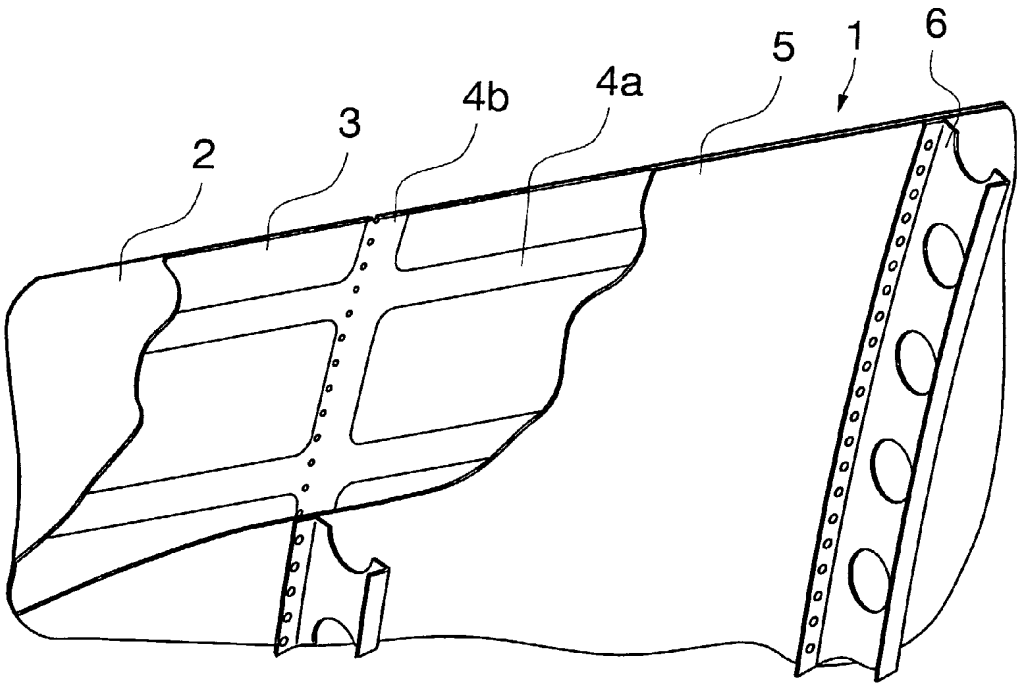
(54) Title: AIRCRAFT PANEL



(57) Abstract: An aircraft panel comprising a sandwich construction with an outer skin portion of high strength material, an inner portion of high strength material and an intermediate core material. The core material includes areas with low density core material and a reinforcement grid of high strength material, with longitudinal and transversal grid members.

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GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for all designations*

— *of inventorship (Rule 4.17(iv)) for US only*

Published:

— *with international search report*

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Aircraft Panel

BACKGROUND OF THE INVENTION

The present invention relates to an aircraft panel and in particular to an aircraft fuselage skin panel comprising a sandwich construction with an outer skin portion of high strength material, an inner skin portion of high strength material and an intermediate core material.

Aircraft, whether military or civil, are subjected to a high degree of stress and need to comply with stated aircraft regulations. Nevertheless, their manufacture must not involve excessive cost. These somewhat contradictory criteria apply in particular to the manufacture of curved skin panels used for fuselage, wings and other part of the aircraft where lightweight materials and simple manufacturing methods are important to keep the cost on an acceptable level.

Today skin panel surfaces on a modern aircraft are supported by one or more of the following methods:

- frames
- stringers
- honeycomb sandwich

Traditional fuselage skin panels are reinforced with circumferential frames and longitudinal stringers. US, 4,498,325 discloses a typical fuselage skin panel with circumferential frames and longitudinal stringers. The combination of frames and stringers is used to give fuselage vessel the required stiffness and the sufficient amount of material to sustain all aircraft loading both from a static and from a fatigue point of view. For the stringer elements in particular, the main purpose is to divide the skin panel surface in an optimal configuration so that deformation of the surface is avoided. The stringers also contribute to preventing cracks from spreading in the skin panel.

Considerable disadvantages exist however in the present design which requires installation of the stringers and frames. Manufacturing of stringers with different geometry is very expensive. Another disadvantage is that stringer installation by riveting is time-consuming and expensive. The method causes a great number of holes through the outer skin, which always increases the potential for corrosion and fatigue problems. Another concern is the intersection where the stringers passes the frames. In the Saab 340 and Saab 2000 project, the frames have cut-outs for the stringers, which decreases the stiffness of the frames. In other solutions, clips are used in the intersection between the stringers and the frames to connect the frame to the outer skin. A problem with this solution is that it increases the complexity in the. Other techniques for stringer installation may reduce some of these disadvantages but are still time-consuming and difficult.

Test with new composite designs are on-going in a number of companies. The composite solutions have a potential to lower the weight significantly because of the unique tailoring capacity. However, there are some major concerns regarding the use of composites in cabin structures that remains to be solved. The epoxy resins, that are used for structural applications, do not meet the Fire, Toxicity and Smoke (FTS) requirements. Furthermore, the crash worthiness requirements are very difficult to meet due to the composites high degree of brittleness. A skin panel manufactured of carbon fiber would not absorb the energy to the same extent as an aluminum panel. A problem with known lightweight designs is that they have proven to be more sensitive to damage and more difficult to repair and maintain. Both these qualities provide for reluctance among the aircraft operators to adopt the new design solutions. This will probably cause more structural break-up and thereby less protection for the passengers unless new composite designs will emerge.

It would therefore be highly desirable to develop new panel structures with reduced weight and increased cost efficiency in the manufacturing.

SUMMARY OF THE INVENTION

The above and other objects are provided by an aircraft panel comprising a sandwich

construction with an outer skin portion of high strength material, an inner skin portion of high strength material and an intermediate core material. The core material includes areas with low density core material and a reinforcement grid of high strength material, with longitudinal and transversal grid members.

In one embodiment the core material includes a lightweight aluminum foam core and a reinforcement grid of aluminum with longitudinal and transversal grid members.

In another embodiment, the skin panel comprises an outer aluminum skin, an intermediate aluminum reinforcement panel, a lightweight foam core and an inner aluminum skin. The intermediate aluminum reinforcement panel and the lightweight foam core are distance materials that makes the panel act as a sandwich construction. The stringers are integrated in the intermediate aluminum reinforcement grid as the longitudinal grid members and can among other things serve as crack arrest devices.

The inventive embodiments are arranged to give the fuselage vessel the required stiffness and the sufficient amount of material to sustain all aircraft loading both from static and from fatigue point of view and to support and provide fixing points for frames within the aircraft fuselage.

A major advantage with the inventive concept is that stringer manufacturing and installation costs can be avoided. Furthermore, the frames for the new skin panel do not need any weakening cut-outs for the stringers. The new panel will attain the same or lower weight than present design solutions.

BRIEF DESCRIPTION OF THE DRAWINGS

The various advantages of the present invention will become appearent to one skilled in the art by reading the following specification and subjoined claims and by referencing the following drawings in which:

Figure 1 is an elevational view of an inside surface portion of a traditional aircraft fuselage with stringers and frame

Figure2 is a fragmentary elevational view of an inside surface portion of the

inventive aircraft panel with integrated stringers

Figure3 is an enlarged view of the panel in Fig 2.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to FIG. 1, there is shown a traditional fuselage skin panel reinforced with circumferential frames 12 and longitudinal stringers 11. Clips 13 are used between each stringer 11 to connect each frame 12 to the outer skin 10. The clips 13 are riveted to the skin 10 and to the frame 12, which is a very expensive and time-consuming attachment.

Referring to FIG. 2 there is shown an aircraft panel 1 comprising a sandwich construction with an outer skin portion 2 of high strength material, an inner skin portion 5 of high strength material and an intermediate core material. The outer skin portion and inner skin portion are preferably both made of aluminum, which is well suited for this purpose both from a cost and crash worthiness aspect. Embodiments where a different high strength material is used for one or both skin portions are also possible. The core material comprises a distance material that makes the panel act as a damage tolerant sandwich construction. This distance material includes areas 3 with low density core material surrounded by a reinforcement grid 4 of high strength material with longitudinal grid members 4a and transversal grid members 4b. In one embodiment a plastic foam is used for the low density core material. An aluminium foam may also be used. The reinforcement grid 4 is preferably made of aluminium.

Referring to FIG 3 there is shown a partial view of the aircraft panel 1 from FIG 2. In FIG 3, the reinforcement grid 4 and the areas 3 with low density core material have been exposed in order to provide a better understanding of the structure of the intermediate core material. The intermediate core material is surrounded from both sides with an outer skin portion 2 and an inner skin portion 5 as shown in FIG. 2.

The reinforcement grid 4 including the inner and outer skin portions increase the buckling capability of the whole skin panel. The transversal grid members are arranged to correspond to the intended position of frames 6. In the embodiment

shown in FIG 2, the reinforcement grid is symmetric with the longitudinal grid members parallel and arranged at equal distance from each other. The intermediate reinforcement grid can easily be optimized to new patterns along the fuselage length depending on the load levels. Increased edge thickness around the panel facilitates the joining conditions to the next panel.

The longitudinal grid members 4a correspond to the stringers used in previous designs of aircraft fuselage panels and contribute to sustain longitudinal loads in a pressurized vessel and to function as crack arrest members. In the circumferential direction, the transversal grid members 4b will function as longitudinal crack arrest members. However, circumferential frames 6 are needed to cope with general stability behavior and other installations in the aircraft and cannot be replaced with the transversal grid members 4b. The circumferential frames 6 are attached to the skin panel by a number of fasteners through the transversal grid members 4b. If the crack arrest feature is introduced longitudinally, the frames 6 may be made thinner and thereby lighter than in the previous solutions . The total amount of material for this new panel construction does not exceed the material required for the previous stringer solution.

The intermediate aluminum reinforcement improves the damage tolerance characteristics in terms of residual strength capability and crack propagation. The panel has a restraining effect on the crack propagation due to the higher panel stiffness and consequently reduced bulging effects. The intermediate aluminum reinforcement provides for a more efficient crack arrest device

The new design provides the possibility to omit the internal stringers shown in Fig 1 without compromising the field stability stiffness in the panels. The circumferential frames 6 are attached to the skin panel 1 by a number of fasteners and the transversal grid members 4b should therefore be dimensioned to allow at least one row of fasteners. The frames can be riveted directly to the transversal grid members and does not need any weakening cut-outs for the stringers.

Increased skin thickness due to the sandwich construction will facilitate the fastener selection to install the frames. The new skin panel will have a positive temperature insulating characteristic and will also improve the noise insulating characteristic. This will provide a possibility for reduced weight in the normal cabin insulation or better noise conditions within the cabin.

Those skilled in the art can appreciate from the foregoing description that the teachings of the present invention can be implemented in a variety of forms. Therefore, while this invention has been described in connection with particular examples thereof, the true scope of the invention should not be so limited since other modifications will become apparent to the skilled practitioner upon a study of the drawings, specification and following claims.

CLAIMS

1. Aircraft panel (1) comprising a sandwich construction with an outer skin portion (2) of high strength material, an inner skin portion (5) of high strength material and an intermediate core material, **characterized in** that the core material includes areas (3) with low density core material and a reinforcement grid (4) of high strength material, with longitudinal grid members (4a) and transversal grid members (4b).

2. Aircraft panel (1) in accordance with claim 1, **characterized in** that the high strength material is aluminum.

3. Aircraft panel (1) in accordance with claim 1 or 2, **characterized in** that the low density core material is a lightweight plastic foam.

4. Aircraft panel (1) in accordance with claim 1 or 2, **characterized in** that the low density core material is a lightweight aluminum foam.

5. Aircraft panel (1) in accordance with claim 1, **characterized in** that the transversal grid members (4b) are arranged to support and provide fixing points for frames (6).

6. Aircraft panel (1) comprising a sandwich construction with an outer aluminum skin portion (2), an inner aluminum skin portion (5) and an intermediate core material, **characterized in** that the core material includes areas (3) with lightweight plastic foam and a reinforcement grid (4) of aluminum with longitudinal grid members (4a) and transversal grid members (4b) and that the core material, the inner and outer skin form a sandwich panel.

Fig 1

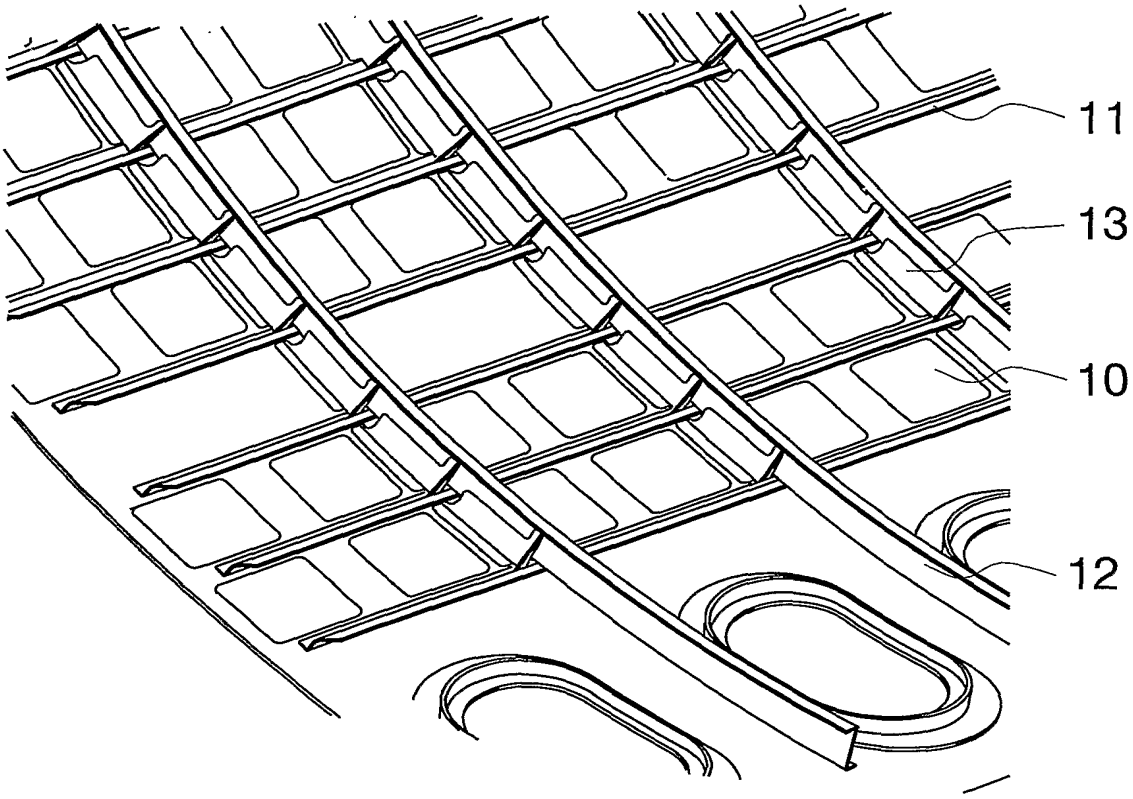


Fig 2

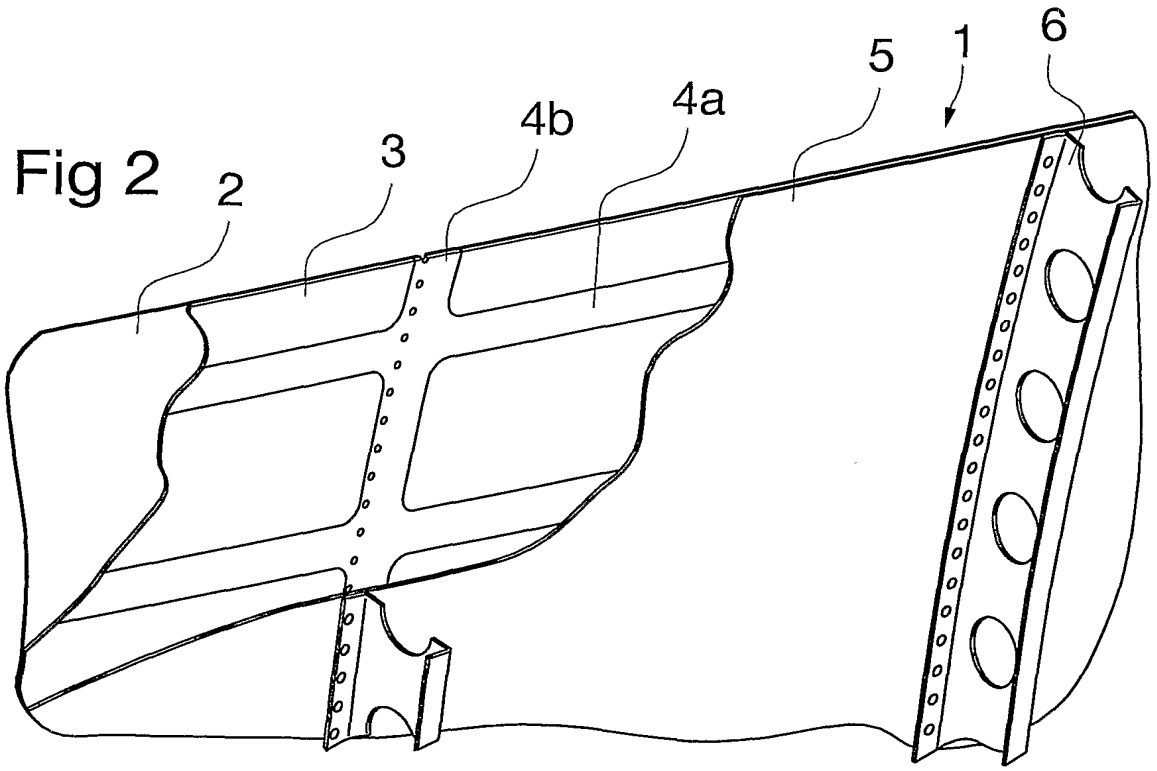
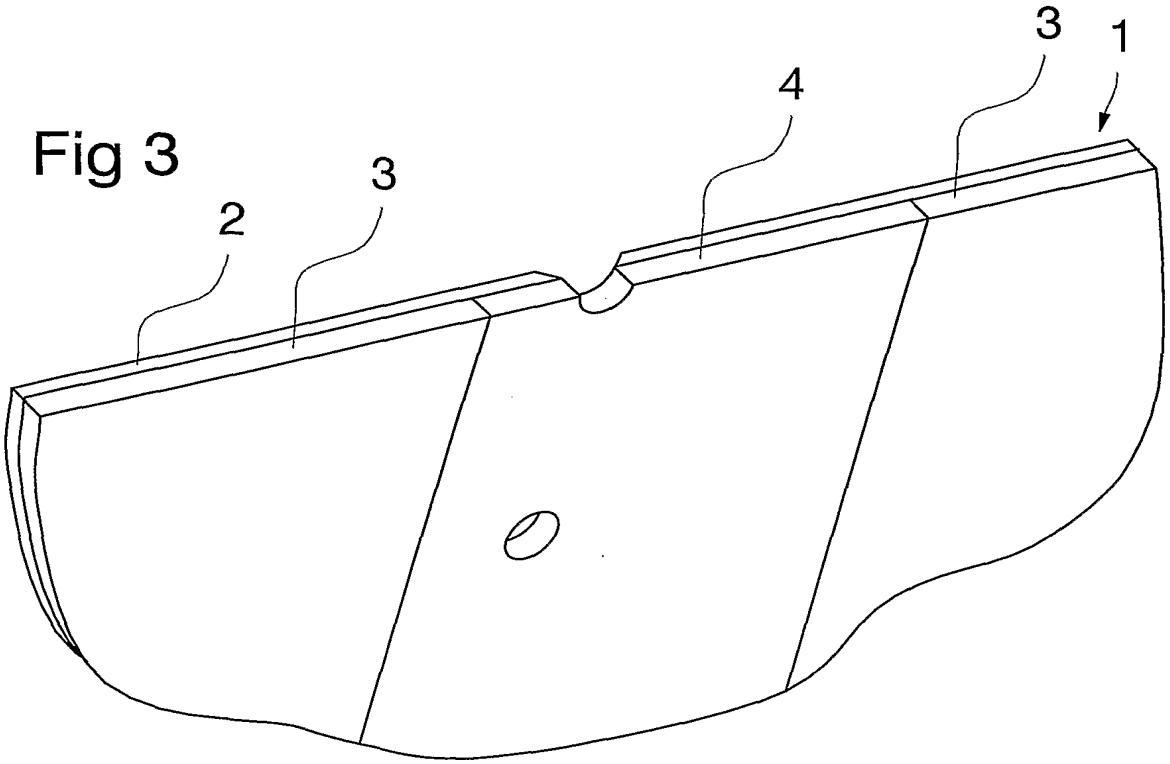


Fig 3



INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 02/00843

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B64C 1/12, B32B 7/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B64C, B32B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4032683 A (COALE), 28 June 1977 (28.06.77), column 2, line 7 - line 20, figures 1,2, abstract --	1-6
A	US 5735486 A (PIENING ET AL.), 7 April 1998 (07.04.98), column 3, line 27 - line 40, figures 1-5, abstract --	1-6
A	DE 19715529 C1 (SCHOKE BEREND), 6 August 1998 (06.08.98), column 2, line 21 - line 35, figures 1-3, abstract -- --------	1-6

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 June 2002	25 -07- 2002
Name and mailing address of the ISA Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Björn Salén/SN Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

01/05/02

International application No.
PCT/SE 02/00843

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4032683 A	28/06/77	NONE	
US 5735486 A	07/04/98	DE 19529476 A,C	13/02/97
		EP 0758607 A	19/02/97
DE 19715529 C1	06/08/98	NONE	